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Title ? ? Obesity Prevention and Weight Maintenance After Loss

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Abstract

Obesity is one of the most prevalent medical diseases in pets, adversely affecting the quality of life of millions worldwide. Whilst weight management programs can be successful, outcomes are often disappointing with many animals either failing to reach target weight, or regaining weight subsequently. Alternative strategies for managing the disease are desperately needed. This article discusses managing obesity by focusing on prevention rather than cure. It gives guidance on establishing monitoring programs that utilize regular body weight and condition assessments to rapidly identify animals at risk of inappropriate weight gain, thereby enabling early intervention. It also emphasizes that weight management in obese animals is a life-long process, that not only requires successful weight loss, but also effective rebound prevention. Again, regular weight and body condition monitoring are key to identifying animals that rebound early, whilst continuing to feed a therapeutic weight loss diet can help prevent it from happening.

Key Points

- The process of inappropriate weight gain is insidious and many animals are at risk.
- Treatment of obesity is challenging and affected animals frequently fail.
- To prevent obesity, veterinary professionals should establish a program of regular body weight monitoring and BCS assessments, starting during growth and persisting throughout adult life.
- Body weight should be monitored regularly during the post-weight-loss phase to identify animals at risk of rebound.
- Feeding a therapeutic weight management diet during the weight maintenance phase significantly decreases the risk of regain

Inappropriate weight gain in dogs and cats

Definition

Inappropriate weight gain typically arises from persistent dietary caloric intake in excess of maintenance requirements, leading to increased adipose tissue deposition. It is a major and ever increasing concern in companion animals and, depending on the degree increased adiposity, is classified as either **overweight** or **obese**. A dog or cat whose weight exceeds 10% of its optimal is classified as being **overweight**, whilst the term **obese** is used to define animals whose weight is 20% above optimal (1).

Prevalence of inappropriate weight gain

There have been various peer-reviewed studies determining the prevalence of obesity and overweight, which suggest that 29-39% and 19-29% of dogs and cats, respectively, may be affected (1). Most concerning is the fact that the problem is becoming increasingly more prevalent, with a recent survey suggesting that the affected population of dogs and cats has increased by 37% and 90%, respectively, in the last 5 years (2). Further, companion animal obesity is now of global significance, with a recent survey demonstrating that 44% of dogs in China were now classified as overweight (3).

Onset of inappropriate weight gain

A recent cohort study demonstrated that, for cats that become overweight later in life, body weight gradually increases through their adult years (4). This is consistent with findings of cross-sectional epidemiological studies that demonstrate that, in both dogs and cats, the relative prevalence of overweight is relatively low early in life, peaks during the middle aged years, and lessens again later in life (5,6), most likely as a result of the development of chronic diseases of old age. Thus, rather than developing suddenly, inappropriate weight gain is a gradual process

that begins during early adulthood life, with adipose tissue accumulating gradually throughout the middle age years. This insidious pattern of onset can prove challenging both for owners and veterinarians because it is easily missed. Proactive monitoring is essential to spot the problem early and enable corrective measures to be implemented (see below).

Risk factors for inappropriate weight gain

A number of risk factors are known to predispose to the development of obesity in dogs and cats (1,5,6), as outlined below.

Co-existing health problems. Many other diseases can alter energy flux, either by increasing energy intake or decreasing expenditure, and these can predispose to inappropriate weight gain (Box 1).

Rapid early-life weight gain. In humans, a fast rate of growth is a predictor of obesity in adult life, increasing the likelihood of being obese during adulthood (7). A similar phenomenon has also been reported in cats (4), with genetic factors thought to be responsible (8). However, it is not yet known whether rapid growth rates are a similar risk factor in dogs.

Breed. The prevalence of obesity is greater in certain dog breeds (e.g. Labrador Retrievers, Golden Retrievers, Pugs, Cocker Spaniels, Beagles, and Mixed-breed dogs), but less in other breeds (6). This suggests that, as in humans (9), genetic influences are an important risk factor. In cats, associations have not been consistently demonstrated between the development of obesity and pedigree cat breeds. Instead, mixed-breed cats (especially the domestic shorthair) are at greatest risk. Nonetheless, genetic factors are suspected to be responsible for the rapid early life weight gain, which is itself a risk factor for obesity in adult life (8).

Age. As discussed already, the peak prevalence of overweight cats and dogs is during the middle-aged years (6-19 years in dogs and 5-11 years in cats) (5,6). Prevalence is less, but not

zero, during the growth phase and during the senior years, the latter probably because of the development of chronic diseases that lead to body weight loss.

Sex and neutering. Male cats were predisposed to obesity in one study (10) whilst, in contrast, female dogs are more likely than male dogs to be overweight (6,11). In both species, neutering is an important risk factor, most likely because the alterations in sex hormones lead to changed behavior, most specifically increased food seeking and decreased physical activity (12-13).

Behavioral factors. Abnormal feeding behaviors have also been implicated as possible risk factor for the development of feline obesity (14), for example, the cat being more anxious or not properly controlling its food intake.

Environment and activity. Both cats and dogs that live indoors, especially in apartments, are more likely to be overweight than those who go outdoors (15-17). In addition, those cats living either with dogs or with 1-2 other cats are also predisposed to becoming obese (15,16).

Dietary factors. The role that diet plays in the development of obesity has not yet been clarified, since variable results have been seen in different studies. A summary of key findings from the studies conducted are reported in Box 2.

Owner factors. A number of owner factors have also been implicated in the development of obesity in dogs and cats (Box 3).

Outcomes of weight management

Various studies have examined the outcomes of weight loss programs in both obese pet dogs and cats (24-26). Most commonly, only short-term assessments are considered (e.g. 2-6 months only), and only simple outcomes reported (e.g. initial rate of weight loss and overall percentage weight loss). These results give the mistaken impression that weight loss programs are highly

successful in both species. Studies examining rates and percentage weight loss over the whole of a weight loss cycle (e.g. long enough to return the animal to their ideal weight) are more representative (27,28), but still do not give a complete picture of overall success. In one study, that examined a weight loss intervention which included client education, only 53% of dogs completed the 6-month trial period (25). A completion rate of 60% was reported for an entire weight loss cycle (e.g. start to reaching target weight) in a more recent study (29), with various reasons cited for non-completion including development of other diseases, poor compliance with the program, and personal reasons of the owner (e.g. owner illness, bereavement in the family). The main factors associated with failure to comply were the degree of obesity (more obese dogs less likely to complete) and slower rates of weight loss.

These findings are consistent with other research that has highlighted that weight loss becomes increasingly challenging the longer an animal is on their weight loss program (30,31). In the early stages of weight loss (e.g. first 2-3 months), both dogs and cats can be expected to lose at ~1% body weight per week, which what most clinicians would recommend as safe weight loss. Thereafter, the rate of weight loss begins to slow down and, in order to maintain rates of weight loss, dietary energy intake must be reduced, usually by 10-20% during the course of a period of weight loss (30,31). However, rate of weight loss declines despite this such that, after 12 months of a program, rates of weight loss are usually <0.3%/week in both dogs and cats. Such slowing of progress can be frustrating to owners and, perhaps explains why compliance, which is good in the first 2-3 months (typically >80% in both species) worsens gradually as time goes on (30,31).

Furthermore, success should not simply be viewed in terms of what happens during the weight loss period. Arguably, it is more important to ensure that any weight lost is not regained. Indeed, this is a common problem with human diet-based weight loss programs, where the

majority of subjects regain weight, and some regain more than they originally lost (32). Recent studies have demonstrated that regain is also a problem in obese companion animals, with 48% of dogs and 46% of cats, rebounding (33,34). In dogs, the magnitude of rebound is typically less severe than in humans, with approximately 10% of dogs regaining over 50% of the weight they originally lost. Cats are intermediate, with ~1/3 regaining over 50% of the weight they had lost. These findings highlight the fact that weight management should never be considered simply in terms of the weight loss phase. Since long-term success involves many of the risk factors that contributed to the initial inappropriate weight gain remain after the program is completed, and veterinary professionals must therefore focus as much effort into prevention of rebound as for the preceding weight loss phase (see below).

The results summarized above clearly highlight the fact that long-term success is relatively disappointing when it comes not only to reaching target weight successfully, but also maintaining that lost. If approximately half of dogs and cats that start a weight loss plan reach target, and only half of those maintain their weight loss subsequently, only a minority (~1/4) derive long-term benefit. However, there is one further factor that must be considered when looking at success of weight management therapy, namely what proportion of obese animals actually undergo weight loss in the first place. To the author's knowledge no study has as of yet addressed this issue. That said, recent studies have highlighted that veterinarians discuss weight status and body condition with owners of overweight dogs in <2% of all consultations (35,36). This suggests that only a minority of overweight animals are identified and the issue discussed with their owner. The number that actually start a weight loss plan is likely to be substantially less than this.

In summary, few obese dogs and cats start a weight loss program, and only a minority of those that do successfully lose weight and keep it off subsequently. This suggests that therapy

for obesity is far from perfect. As a consequence, a new approach is needed in order to manage this epidemic, instead focusing on prevention rather than cure.

Tools for obesity prevention

As discussed above, the challenges faced with successfully losing weight after and keeping it off mean that it makes more sense to prevent inappropriate weight gain from developing in the first place. This can be more challenging than it sounds, not least because the problem develops insidiously, such that it is often missed until it is too late. Prevention of obesity is a lifelong problem, requiring interventions right from the early growth phase through to the senior adult years. It requires the veterinary professional to pay constant attention to maintaining a neutral energy balance (in terms of dietary energy intake relative to energy expenditure) whilst, at the same time, confirming this through regular monitoring of body weight and condition. Whilst the main tools for obesity prevention are similar, the strategy adopted is different at different stages, which are considered separately below.

Monitoring strategies

Body weight. Arguably, taking regular bodyweight measurements are the most important monitoring strategy for preventing inappropriate weight gain and, provided that the same set of calibrated electronic scales is used, it is much more precise and objective than other approaches (e.g. body condition scoring, using a tape measure). Even small deviations from optimal weight can be spotted quickly enabling early intervention. Items such as clothing or harnesses should be removed, if possible, and the animal should be positioned so that they are standing with all four feet on the scales. The animal should also be as still as possible during the weighing process, and the result should be immediately recorded in the animal's case notes (to two decimal places for all cats and small breed dogs, and one decimal place for medium to giant

breed dogs). If not doing so already, veterinary clinics should instigate a policy of weighing all animals at every single visit since, over time, an individualized historical record of body weight will be available for all registered patients.

Body condition. Body condition scoring (BCS) is the most widely accepted clinical method of assessing body composition because it is very quick and easy to perform, whilst at the same time being reliable. It is important that the veterinary professional conduct the assessment, because owners under-estimate the condition of their pet. Various BCS systems have been described, but the WSAVA Global Nutrition Committee recently made a recommendation that the 9-point system be universally adopted (37). As well as determining current weight status (underweight, optimal weight, overweight), knowledge of the current BCS can be used to estimate optimal weight, should it deviate from normal (Box 4).

Other methods for determining body condition. In addition to regular assessments of body weight and periodic BCS, other methods can also be considered including zoometry, bioimpedance and advanced body composition assessments. Zoometry involves measuring bodily dimensions with a tape measure, and can either be single measurements to informally assess aspects of overall shape (e.g. body circumference measurements) or multiple measurements which are combined in a formal zoometric system (38,39). However, while such systems do correlate with body fat mass, there can be variability in measurements taken with a tape measure (40), and the systems are more cumbersome to use taking longer than assessing BCS. Bioimpedance techniques for assessing body fat mass have also been described, and handheld machines are available. However, lack of reliability means that results can be misleading (41). Finally, advanced measures have been described for more accurately assessing body composition in small animals, including dual-energy X-ray absorptiometry and computed

tomography (42,43). These techniques have limited application for primary care practice, and are more suited to a referral setting, should the need arise.

Determining metabolizable energy requirements and energy expenditure

To help with proactive monitoring, knowledge of an animal's metabolizable energy requirements for maintenance (MER) at different life stages is useful, and predictive equations for different stages of life have been reviewed and reported (44,45). However, whilst such equations are accurate on average, the specific requirements for an individual can deviate markedly. Therefore, after calculating expected MER with such an equation, the exact requirements should be adjusted on a trial and error basis, e.g. by taking serial measurements of bodyweight, and adjusting food intake accordingly (see below).

Research methodology is available for measuring energy expenditure (a proxy measure for MER), with techniques including indirect calorimetry and tracer studies involving, for example, doubly-labelled water (43). Indirect calorimetry has been adopted as a clinical measure in humans (44), and portable indirect calorimeters have been developed. The clinical use of indirect calorimetry has also been validated for dogs (45). However, this technique has not yet found a wide clinical application in the veterinary field.

Dietary strategies

In order to best frame discussions regarding diet and food intake, a nutritional assessment is recommended, ideally in accordance with the recent recommendations of the WSAVA Global Nutrition Panel (37). Such an assessment will enable the individual needs of the animal to be taken into account when setting the prevention strategy to adopt. Dietary strategies that can help in preventing inappropriate weight gain include determining the most appropriate main meal to feed, adopting a responsible plan for providing treats and extra food, accurate

measurement of food portions, managing feeding activity within and outside the home, and adapting food intake as nutritional requirements change.

Periodically, it is advisable to reappraise the animal's nutrition (again using the WSAVA Nutritional assessment), since actual feeding regimes can 'drift' gradually over time. Such a review helps to refocus priorities, adjust the strategy if there have been changes in circumstance, and ensure continued commitment from the owner in preventing weight gain.

Main meal feeding. All dogs and cats should be fed a diet that is nutritionally complete and balanced and, preferably, tailored to the correct life stage, be it for growth, the early adult period, or for the senior years. If the current diet is appropriate, and both owner and pet are happy with it, then there is no need to change. Instead, attention should be focused on ensuring that the correct amount is being fed for requirements, and adjusted as needs change. Particular care should be focused when changing to a new diet (Box 5).

For dogs and cats that show marked food seeking behavior or excessive begging, a change of food type can be considered. The same characteristics as those used in a purpose-formulated weight loss food will also help for weight maintenance. For example, food can be supplemented with protein and fiber, are known to minimize signs of hunger and reduce voluntary food intake in both dogs and cats (24,46). Increasing food volume can also reduce voluntary food intake, for instance by adding water (or using a wet food) or expanding a kibbled food with air. Finally, the shape of a kibbled diet can also be altered, which can force a dog or cat to chew food more, thereby slowing intake.

Accurate portion size measurement. In addition to accurately determining MER, it is critical that there is both precision and accuracy when measuring food portions. This is most important for dry food because it is so energy dense, and small errors can lead to large differences in actual energy intake. Whilst measuring cups may be the simplest method of measuring dry

food, they are unreliable, and can lead to overfeeding especially for small portion sizes (such as those fed to small dogs and cats) (47). For those animals known to be at risk of inappropriate weight gain or over-eating, more accurate measurements are critical, and a different method is strongly recommended, if possible, using digital gram scales. In practice, it takes very little additional time in measurement and gives owner and veterinary professional reassurance that correct portions are being delivered day in and day out. Other methods that are currently in development include 'smart bowls' and computer-controlled food hoppers, which include gram scales within them, and automatically measure out the correct portion with the minimum of effort.

Responsible feeding of treats and extra food. It is critical to control the feeding of extra food, such as tit-bits, table scraps, treats, and food scavenging. Most owners frequently are not aware of the contribution that such food sources can make to the daily ration. During the initial nutrition review, time should be taken to obtain a detailed understanding of the extra food the animal receives, and, in order to make this as accurate as possible, it is advisable to question multiple family members. In theory, it is preferable to avoid feeding any additional food, since there is a danger that it may make an otherwise balanced main meal unbalanced. In reality, most owners will not accept this because rewarding their pet is such an instinctive behavior. The solution, is to develop a formal program of treating, which either makes use of existing food or, instead, permits the owner to use a controlled number of approved treats, to a maximum of 10% of MER, so as to ensure that the diet remains in balance overall. The energy content of such treats should be calculated and the amount of main meal fed should be reduced accordingly.

Ideally, human food and table scraps should still not be fed. To minimize temptation, it is best to ensure that pets are not in the kitchen area where food is being prepared, and not allowed

access to the dining area during meal times. Food preparation areas and dinner tables should be cleared before the pets are allowed back in, whilst trash bins and food stores should be properly secured. Finally, care should be taken when dogs are taken for walks. If scavenging at this time is a problem, it may be necessary for the dog to wear a muzzle or not be let off the lead.

Methods of feeding. Again, the initial nutritional assessment should include a discussion of how the owner feeds their pet(s). Most commonly, dogs will be given 1-2 main meals each day, and meal feeding is also common for cats, though some owners will leave food out all day. The latter should be discouraged, not least in multi-animal environments and with cats that are unable to regulate their daily food intake (see below).

It is worth considering the use of puzzle feeders as part of the overall feeding strategy. These are an excellent method of slowing food intake, thereby extending the feeding period. Not only does it help to minimize over-eating (since there is more time for gastrointestinal hormones that lead to satiation to be released and affect the hunger center in the brain), but it also is more enjoyable for the pet.

In multi-pet households, it is critical to ensure that each has their own tailored feeding plan and only receives its own food. Various strategies can be used (Box 6). It can be a particular challenge when managing multi-cat households with one grazer cat (that is in ideal weight) and an overweight cat that does not regulate intake. Food should never just be left out and, instead, pets in the same household must be fed separately. For example, a 'grazer', that can self-regulate, can be allowed long periods to be fed whilst the cat that tends to over-eat is given food by puzzle feeder. Alternatively, food could be left out for the grazer in a location that the overweight cat cannot access (on a high surface, within a small 'creep' area (e.g. box or cupboard with small hole through which the overweight cannot pass), using a smart bowl to

allow free access for the grazer, whilst meal feeding or using a puzzle feeder in the overweight cat.

If desired, food can be given in two, or more, meals per day, preferably providing more food at times when the owner is with the pet (since this is when begging is most likely to occur). However, use of an interactive feeding device is preferred (e.g. puzzle feeding toy, or modified feeding bowl). These devices have the effect of slowing food intake, thereby improving satiety.

Physical activity

In addition to controlling food intake, promoting energy expenditure is a valuable means of helping to prevent inappropriate weight gain. The main approach in both cats and dogs is to increase physical activity, which has a modest but significant effect on energy expenditure in most animals. Indeed, in a recent canine study, each 1000 steps of walking increased energy expenditure by 1kcal per kg^{0.75} of body weight (48). In addition to burning calories, physical activity can improve and maintain cardiovascular and musculoskeletal fitness, and improve the owner-pet bond. Regular daily sessions are recommended for both species, although the approach varies (Table 2). For dogs, at least one daily walk of 30 minutes is recommended. When play sessions are used in cats, short periods are sufficient activity, typically 1-2 minutes at a time 2 or more times per day.

The recommended exercise should take account of any concurrent medical concerns, and also be tailored to the capabilities of the pet. For example, if a dog has an orthopedic disease (such as osteoarthritis), controlled forms of exercise, such as leash walking are preferable to vigorous activity (off-leash running and playing with a ball). Alternatively, hydrotherapy could be used, dependent on cost and availability in the local region. Finally, the agreed plan should also take account of the preferences and capabilities of the owner, in terms of the time available, timing, and type of exercise.

A final method that can help to promote movement in both cats and dogs is the use of puzzle feeders, hollow toys in which you place a small amount of kibbled food. The cat or dog must then play with the toy to remove the food. Most animals rapidly learn how to use these, and will play for extended periods, often well after the toy is empty.

Recommendations for monitoring strategies

Early life prevention

The importance of ensuring that dogs and cats grow at an appropriate rate during their early years cannot be over-emphasized since this is the foundation to a healthy weight for the whole of the adult years. Epidemiological studies in humans have demonstrated that inappropriate growth is a predictor of obesity later in life (7). Indeed, a rapid rate of growth, catch-up growth (where an underweight for age child grows faster than average), and high early-life body mass index are all independently associated with the risk of obesity at 7 years of age. A recent study has also demonstrated rapid growth to be a risk factor for later-life obesity in cats (4). To the author's knowledge, no similar studies have as of yet been done in dogs. However, given the fact that this effect appears to be conserved across two species, an important effect of growth on the risk of inappropriate weight gain in the future is likely also to exist in dogs.

Given such an importance to the growth period, regular monitoring of body weight throughout the growth phase is essential. Indeed, growth standards are now widely used in human pediatrics, with the most commonly adopted being those endorsed by the World Health Organization (WHO). Such growth standards enable appropriately-trained health workers to monitor individual growth in children and verify that it is appropriate compared with a healthy reference population (49). Regular weight monitoring can then be performed, and guidance can be given should the child's growth deviate from optimal. Unfortunately, such growth standards

are not yet available for cats and dogs, and this can make charting healthy growth more challenging. Nonetheless, the principles of regular growth monitoring can still be applied to both dogs and cats. Recommendations for weight monitoring during growth are shown in box 7.

Monitoring strategy for adult animals

Inappropriate weight gain is an insidious phenomenon, and the early adult years are a particular period of risk. Indeed, the prevalence of overweight animals steadily increases in this period to a peak in mid-adult life. Therefore, regular and proactive monitoring is critical as a means of identifying at risk animals, and making early corrections to prevent animals becoming overweight. The main recommendations for prevention of inappropriate weight gain during adult life are shown in **Box 8**.

Monitoring strategy for the post-neutering period

Neutering is a risk factor for inappropriate weight gain in both dogs and cats, although its influence varies amongst individuals. As a consequence, close monitoring of body weight and condition is essential during the post-neutering period (**Box 9**).

Monitoring strategy for senior animals

Weight checks should be continued into the senior life stage. Not uncommonly activity can decline at this stage, not least because of concurrent diseases such as osteoarthritis have developed. Any increases in weight should prompt a nutritional and lifestyle review, with adjustments made as required. Of course, old age is also a time when chronic diseases are common, many of which can lead to loss of body weight, and especially body mass. Thus, the clinician should be alert to this possibility, and any unexpected decline in body weight should be investigated proactively to elucidate the cause. It is also common for animals to gain adipose tissue whilst at the same time losing muscle mass. For this reason, regular assessment of body

condition is also vital, and this should include a subjective assessment of muscle condition [53]. For most senior animals, 6-monthly checks will be sufficient. However, more regular monitoring should be considered for animals known to have a chronic disease that causes loss of body weight e.g. chronic kidney disease, hyperthyroidism etc.

Prevention of rebound post-weight loss

As mentioned above, subsequent regain of body weight is a common occurrence after successful weight loss in obese dogs and cats, with about half of those reaching target weight that are affected (33,34). In dogs, the main factor that decreases the odds of such a rebound occurring is the food that is fed during the weight maintenance phase (33). In this respect, weight regain is far less likely in those that continue to be fed the same purpose-formulated food that was used during the weight loss phase, than for dogs whose diets are switched to a different diet (for instance a standard canine maintenance diet or 'light' maintenance diet). In cats, the main factor associated with weight regain is age, with cats <9 years being at greater risk than cats >9 years of age (34). Therefore, particularly close monitoring of the post-weight-loss period is essential for younger cats. As for dogs, the author recommends that these cats continue with the purpose-formulated diet that was used during weight loss. The reason why older cats are less at risk of regain is not known, but may be related to the onset of chronic diseases during the senior years, many of which can lead to insidious weight loss. Therefore, there is less of a need to remain on the purpose-formulated weight loss diet (as for a young cat or dog) and, instead, a food should be selected that is appropriate to the life stage and or concurrent disease. Nonetheless, regular monitoring of body weight and body condition should continue, with adjustments being made to ensure weight is stable. The author's recommended plan for proactive monitoring of the weight maintenance phase is shown in Box 10.

Conclusions

The process of inappropriate weight gain is insidious, and many animals are at risk of becoming overweight or obese. Prevalence reaches its peak during the middle-aged years and, once obesity is established, it can be immensely challenging to treat. Few animals start a weight loss program with many of those that do either failing to reach target weight or rebounding afterwards. As a result, veterinary professionals should focus on prevention of obesity, rather than attempting to manage it once it has developed. Veterinary practices should consider establishing a formal program of monitoring body weight and regularly assessing BCS, with strategies tailored to the life stage. As soon as there is evidence of inappropriate weight gain, there should be early intervention with corrective measures. Finally, if an obese animal does successfully lose weight, veterinarians should closely monitor post-weight-loss period, with regular follow-up weight checks to ensure that bodyweight remains stable. Continuing to feed the therapeutic weight loss diet during the maintenance phase can help to prevent rebound from occurring.

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Table 1. Methods of promoting physical activity in dogs and cats.

Dog	Cat
Walking (on or off leash)	Play activity using fish rod toys
Play activity using balls, frisbees etc	Motorized toys
Hydrotherapy	Puzzle feeders
Puzzle feeders	Climbing frames and activity centers
Free exercise outdoors (in yard or garden)	Allow outdoor access (e.g. cat flap)

Box 1. Diseases that might predispose to inappropriate weight gain by altering energy flux

- Hyperadrenocorticism causes polyphagia and can predispose to increased energy intake
- Side effects of some drugs, e.g. glucocorticoids and anticonvulsants include polyphagia which again might lead to weight gain
- Neutering is a risk factor for inappropriate weight gain (see below), and may be required for treatment of diseases like pyometra
- Orthopedic diseases decreases energy expenditure by decreasing physical activity
- Hypothyroidism decreases energy expenditure by decreasing basal metabolic rate

Box 2. Dietary factors associated with overweight or obesity in dogs and cats

- No association between diet type and obesity in cats (15,18)
- Dry food as risk factor for development obesity in young cats (17)
- Dietary fat content, rather than carbohydrate associated with obesity in cats (19)
- Feeding free choice appears to increase the risk of obesity in cats (15,16)
- An association between numbers of meals and snacks and obesity in dogs (20)
- Feeding of table scraps associated with obesity in cats and dogs (15,16,20,21)
- Cat or dog present when food is prepared (15,16,20,21)
- 'Grocery store' dog foods positively associated with canine obesity (18)
- 'Premium' cat foods positively associated with feline obesity (5).

Box 3. Owners factors implicated in the development of overweight and obesity in dogs

- Lower average income for owners of overweight dogs (18,22), but not cats (23)
- Over-humanization of the dog by the owner is associated with obesity in dogs (18)
- Cat utilized by owner as a human companion substitute (23)
- Close observation of feeding behavior of the cat or dog (18,23) Less time spent playing with cat (23)
- Owner obesity positively associated with obesity in dogs (18) and cats (23)
- Owners of obese cats less interested in preventive health (18,23)
- A stronger owner-animal bond is reported between obese cats and their owners (14).

Box 4. Estimating ideal bodyweight from current bodyweight and body condition score

It is estimated that each unit between 5 and 9 on the 9-point body condition system approximates to 10 per cent of additional bodyweight. After weighing the animal, and assessing BCS, a simple calculation can then be used to estimate the ideal weight:

$$\text{Ideal weight} = \text{Current weight} \times (100 \div [100 + 10 \times \{ \text{current BCS} - 5 \}])$$

Example

For an animal weighing 40.0 kg with a current body condition score of 8/9 (i.e., about 30 per cent overweight), the ideal weight can be calculated as follows:

$$40 \text{ kg} \times (100 \div [100 + 10 \times \{ 8 - 5 \}]) = 30.8 \text{ kg}$$

Always be aware that such calculations only ever provide an estimate of ideal weight, and can be prone either to over- or under-estimation of actual ideal weight. It is advisable for the veterinary professional to monitor body condition during the weight loss process, and make adjustments if needed.

Box 5. Advice on procedures for introducing a new food, and adjusting intake to ensure energy intake remains in balance.

- Introduce it gradually, over 5-7 days, to avoid any gastrointestinal disturbances.
- Calculate the correct amount of food to feed, based upon the animal's maintenance energy requirements, if known. If not known, follow the manufacturer's guidelines, adjusted to the animal's individual circumstances e.g. its current body weight, breed, sex, neuter status, activity level etc.
- Feed the food for a 2-week period and reweigh the animal. If the weight has remained stable, continue to feed the same amount of food; if the bodyweight has decreased, increase the amount fed by 5-20% (depending upon the amount of weight lost), and reweigh after another 2 weeks; if the bodyweight has increased, decrease the amount fed by 5-20% (depending upon the amount of weight gained), and reweigh after another 2 weeks.

Once bodyweight is known to be stable, continue to weigh the animal at regular intervals to ensure that weight remains on track.

Box 6. Strategies for ensuring separate feeding of individuals for multi -animal households.

- meal feeding animals in separate locations
- feeding in the same location but supervising food intake and picking food up when animals have finished
- using individual smart-bowls programmed to recognize the microchip of the animal
- using separate feeding strategies for different pets (e.g. meal feeding one, and using a puzzle feeder for another; meal feeding a cat that cannot regulate whilst providing a separate location or smart bowl for a cat that is a grazer).

Box 7. Recommendations for weight monitoring during growth in cats and dogs

- Weight should first be recorded at first vaccination and recorded again at second vaccination. At this stage, the importance of healthy weight and healthy growth should be discussed with the owner, and a growth monitoring plan be implemented. Nutrition for growth can also be discussed.
- Body condition scoring should also be performed regularly during this time. Although systems have not been fully validated in growing animals, they can still provide guidance as to whether the weight is appropriate for the age.
- Ideally, regular weight and condition score checks should be performed on a monthly basis until the animal has reached its mature body weight (approximately 12 months for cats, 12-24 months for dogs). Compliance can be improved if these checks are coordinated with other preventive medicine visits e.g. worming, neutering and microchipping etc.
- If weight gain is deemed to have occurred too rapidly or too slowly, adjustments to the nutrition plan can be made, which should have the effect of slowing subsequent growth to get the animal back on track.
- Pay particular attention to any animal that grows rapidly since this is likely to put them at increased risk of being overweight later in life. Owners should be forewarned that a rigorous policy of weight monitoring will also be essential for the adult years.
- Careful monitoring of the post-neutering period to prevent weight gain associated with the post-neutering period (see Box 8).

Box 8. Recommendations for prevention of inappropriate weight gain in adult cats and dogs

- Be aware of the risk factors for inappropriate weight gain (see "*Risk factors for inappropriate weight gain*"). Monitor at risk animals closely throughout their adult years. Be especially alert to cats that gain weight rapidly during the growth phase; these cats are likely to be unable to regulate their food intake. Avoid free access to food (especially a dry kibbled diet), and accurately measure food portions so as to prevent over-eating.
- Perform a number of weight measurements around the time of physical maturity and combine these with assessment of BCS. Provided that the animal is in optimal condition (BCS 4-5/9) when this 'early adult weight' is recorded, the weight can then be used as the healthy weight for the whole of the adult years.
- Once the individual healthy adult weight is known, implement regular weight checks throughout the adult years to ensure that weight remains stable. It is preferable to use changes in body weight to determine the need for adjustments, rather than using BCS. This is because body weight measurements are more objective, easier to perform, and can identify much smaller changes than can BCS. In this respect, body weight changes of 0.5% can readily be identified using properly calibrated electronic scales. In contrast, a ~10% change in body weight is typically required before the BCS changes by 1 BCS unit (on the 9-integer scale).
- Alterations to feeding and lifestyle should be considered if a change in bodyweight is identified between veterinary visits. *Of course, it is up to the attending veterinary professional to determine whether or not intervention is necessary, and the exact intervention required.* The author's recommended intervention points are as follows:

- *>2% change in body weight over a period of 7 days*
 - *>5% change in body weight over a period of 4 weeks*
 - *>10% change in body weight over a period of 6 months.*
- Be aware if there are any changes to the animal's routine e.g. change of diet, change in activity pattern, development of a concurrent disease. Consider more regular monitoring of body weight during these times, and make adjustments to the nutritional plan as required.
- As for growing animals, monitor the post-neutering period carefully, so as to avoid inappropriate weight gain at this stage (see Box 9).
- Consider implementing different feeding methods (e.g. puzzle feeders, smart bowls) if the owner is finding it challenging to limit food intake.

Box 9. Recommendations for monitoring for inappropriate weight gain in the post-neutering period

- Measure body weight and BCS at the time of neutering to ensure that the dog or cat is in optimal condition.
- Reweigh 2 weeks after neutering e.g. at the time of suture removal.
- Reweigh at 4 weeks post-neutering.
- If neutered as an adult, reweigh at 12 weeks, and then 6-monthly thereafter. If body weight increases by >5%, then make adjustments to the nutritional plan (e.g. decrease food intake by 10%) then reassess weight every 2 weeks, making further adjustments until weight is stable again.
- If neutered during the growth phase, reweigh according to the usual practice policy e.g. on a monthly basis. Consider plotting weight change on a graph since this will enabled a 'neutering bounce' (more rapid and inappropriate gain of weight after neutering) to be identified more readily. If seen, make adjustments to the nutritional plan (e.g. decrease food intake by 10%) then reassess weight 2 weeks later, making further adjustments until rate of growth is back on track.

Box 10. Recommendations for preventing regain of body weight after successful weight loss in an obese dog or cat.

- Once target weight is reached, increase food intake by a small increment (e.g. 5-10%) and reweigh the animal two weeks later.
- If there has been further weight loss at the next revisit, increase by a further 5-10% and reweigh after a further two weeks.
- If weight regain has occurred at the next revisit, decrease food intake by half the amount of the last increment (e.g. decrease by 5% if you increased by 10% initially), and reweigh after a further 2 weeks.
- Repeat the process of adjustments (e.g. further small increments or decreases and 2-weekly weight checks) until weight is stable between checks.
- Once weight is stable after 2 weeks, continue to reweigh, but gradually extending the interval e.g. 4-weekly, 8-weekly, and then 3-monthly. Thereafter, weight checks should be continued on a regular basis. For most animals, this can be according to the usual practice protocol for adult animals at the appropriate life stage. However, for animals at particular risk of regain (e.g. those that lost more weight during their weight loss period, young cats, cats known to be unable to regulate their food intake), more regular checks could be considered.